THE PHILOSOPHICAL VIEWS OF AGASSIZ.

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THE school of biological thinkers and writers to which Louis Agassiz belonged was that of Cuvier and of Owen. He was, however, the pupil of Döllinger, who revolutionized the methods of teaching in zoology, and he warmly sympathized with and adopted the views and principles of Von Baer, the great embryologist.

The half-century which has passed since Agassiz came to America has seen a profound and widespread modification of the methods of attacking biological problems. The facts may be of the same general nature, but their interpretation has radically changed; and it is fair to say that the labors of Agassiz in embryology and paleontology had some influence in leading to this change.

The impression made by Agassiz on the writer's mind, when a student for three years in the great museum he founded, was one of admiration at his broad, comprehensive, and synthetic views, his facility in wide generalization, his knowledge of the work done by his contemporaries and predecessors in comparative anatomy, embryology, and systematic zoology, and his acquaintance with the literature of these subjects. We realized that he was constantly in touch with the leading investigators in Europe. We were sure we were enjoying the privilege of working under the direction of a ripe zoological scholar and of the best equipped teacher of his age. It did not seem necessary to go to Germany, for we were enjoying advantages equal to those of the best German laboratories.

To-day we find more practical teachers than Agassiz, in that the student receives more of the teacher's time, is carried on from one step to another, is taught the use of the microtome and of reagents, and in most cases — for there are brilliant exceptions — half or two-thirds of the results as embodied in the doctor's thesis represent the work of the teacher who has

suggested the subject and laid out the plan of study, with a minor portion really contributed by the student himself.

Agassiz may have left his students too much to themselves, but he had what most teachers do not possess, — the power of leading his students to take broad views of a subject. As a teacher, then, Agassiz was broad and philosophical, and his pupils were constantly urged to add to their special work on the anatomy or embryology of some animal a wider knowledge of the relations of the animal itself to its allies and to the world it lived in, and more particularly to its fossil allies.

Philosophy inquires into the causes and meaning of things, philosophy thinks and speculates, and philosophy is nothing unless comparative in its methods. Agassiz was in season and out of season urging us to think at every stage of our investigation, to inquire what is the meaning of this or that feature or change in organs during growth, and at every step we were told to compare. His earliest lectures, delivered to popular audiences, soon after his arrival in this country were on "Comparative Embryology." The great museum he founded was the Museum of Comparative Zoology. Whatever he wrote or whenever he spoke his ideas were large, synthetic, and philosophical. It was these magnificent qualities, together with his undying enthusiasm, which made Agassiz one of the greatest of teachers in that line of great teachers of modern biology whose intellectual parents were Döllinger and Von Baer.

From Agassiz as a philosophical teacher let us turn to his work as an investigator, and inquire whether philosophic, synthetic methods were here employed by him.

Undoubtedly Agassiz's most important, far-reaching, and permanent contribution to science was the glacial theory. At the outset prejudiced against the idea of Venetz and of Charpentier as to the former great extent of the Swiss glaciers, after personal conversation and discussion with the latter geologist he became convinced of his error. He spent several summers among the Swiss glaciers, afterwards visited Great Britain, observed moraines, studied rocks and boulders, and inferred that glaciers had formerly existed in Wales and Scotland, that northern Europe had once been

mantled in ice, and that there had been a great ice age in that part of the earth. If he was a philosopher, he was not less a man of the world, a skillful and ready debater, a hard hitter in controversy, a persuasive and silver-tongued orator; and thus equipped, he overcame the prejudices of the geologists of that day, who were then wedded to diluvial currents, debacles, as well as impossible subsidences; and before his advent to these shores, he had convinced the scientific world that the greater part of the eastern hemisphere had been ice clad. Always observing and comparing, when he landed at Halifax and journeyed to Boston, afterwards geologizing in the White, Green, and Adirondack Mountains and about Lake Superior, he firmly established the truth of a general glacial period. And it is rather interesting to note that while the universality of the Darwinian theory of the formation of atolls by subsidence is now very generally called in question, and the adequacy of the theory of natural selection as a *vera causa*, or at least a primary factor, in evolution is denied by such a philosopher as Herbert Spencer, and by many evolutionists, the glacial theory is universally held, its opponents being so few that we can count them on the fingers of one hand.

When, however, we consider Agassiz as a zoologist or a biologist, and remember the determined way in which he opposed the doctrine of evolution in pre-Darwinian days, attacking on every occasion Lamarckism and the views of the *Vestiges of Creation*, and after the publication of the *Origin of Species*, letting no opportunity be lost in combating its supposed heretical views, we might be led to say, as has been said, that, after all, Agassiz was no philosopher; that he was slightly fanatical and somewhat bigoted and set in his views and illogical in his methods. It is true that in his prime and after a lifelong work in teaching the facts and principles which underlie and form the foundation on which the doctrine of evolution rests, he illogically stopped short of obvious and natural conclusions, and, unlike Lyell, Dana, and others, failed to adopt the new views.

The causes of his failure to come into line with the new zoology were in part, perhaps, the result of theological preju-

dice, of scientific conservatism, and other subtle reasons, and in part the result of his trained scientific mind accustomed to think more or less in one channel, not allowing itself to speculate too freely on too few facts. On the whole, however, the theory of descent was contrary to his whole nature and training; we can in this regard only liken the career of this great naturalist to one of his own "closed types." There are zoologists who attempt the impossible; who would refer, for example, the origin of vertebrates to Crustacea or to Limulus, overlooking the fact that these classes are the final terms in lines of development and are fully completed. So the special creation idea was unproductive, and a Darwin was needed to open men's eyes to new conceptions, to illumine well-known facts from a fresh point of view.

But it should never be forgotten that Agassiz from the beginning of his career advocated certain doctrines which underlie the theory of descent. The first of these is the foundation of the biogenetic law. He insisted that the development of the individual is an epitome of that of the order or class to which it belonged, though unfortunately he stopped short of the logical outcome of such a generalization; *i.e.*, that there is an organic or genetic connection between the forms composing the class.

The second principle is the parallelism between the geological succession of animals and their respective rank in the present period. He points out repeatedly that the lower types preceded the higher. For example, in the Crustacea the gradation of forms presents the most perfect coincidence with the order of succession of these animals in past geological ages. His "lowest" forms are the generalized types of zoologists of the present day, and his "higher" types the more specialized.

All this prepared the minds of his students to accept the truth of a process of evolution of life-forms from the generalized to the specialized types. His "embryonic," "synthetic," and "prophetic" types are in many cases the ancestral types of the modern evolutionist. His embryonic types "represent in their whole organization early stages of the growth of higher representatives of the same type." He maintained that "the

phases of development of all living animals correspond to the order of succession of their extinct representatives in past geological times. As far as this goes, the oldest representatives of every class may then be considered as embryonic types of their respective orders or families among the living."

Agassiz's prophetic types are those which "combine in their structure peculiarities which at later periods are only observed separately in different distinct types." As examples he mentions the ganoids, fishes, pterodactyles, and the ichthyosaurs. He, however, regarded ganoids as more distinctively synthetic than prophetic types. Now we refer the origin of bony fishes, of Amphibia, and of reptiles to the ganoids. Agassiz fully appreciated the more salient facts on which this generalization rests, and we may think it strange that it did not occur to him that the connection could only be explained by supposing that it was a genetic one.

In this respect Agassiz did not rise above the limitations of his time and of his own nature, but the facts he worked out, or which his students and collaborators discovered, were freely given to his students; and in this respect if he did not grasp, or was unwilling to accept, the conclusions of Lamarck and of Darwin, he paved the way for the adoption by his students of evolutional views.

How well does the writer remember a conversation he once held with Agassiz at Penikese, in the summer of 1873. We had given a lecture to our class on Limulus, the horseshoe crab, its structure and mode of development, at the close advocating without reserve the view that Limulus does not stand alone, but that it is genetically related to other jointed animals, and that there are different lines of development of life-forms. At the close of the hour, and after the class had scattered to the work tables, Agassiz, who had been present, strode up and down the room in a state of evident, though repressed, excitement, and then remarked to us with one of his most genial smiles on his lips: "I should have been a great fellow for evolution if it had not been for the breaks in the paleontological record." We replied: "But, Professor, see what great gaps in the higher vertebrates have been filled by the recent discoveries of birds

with teeth, and of Tertiary mammals connecting widely separated existing orders." And then, with a few more words, which we do not distinctly remember, we separated. Not a sign of displeasure during that August afternoon disturbed the genial and sweet nature of the great naturalist. He was not then, though occasionally so, dogmatic. The touch of bigotry, if we may use so strong a word, which existed in his, as it does in many an intense, eager, clear-minded spirit, did not then crop out, and it was one of the most delightful moments we ever spent with that eminently lovable man. Agassiz had then just passed his sixty-sixth year; and, after having for years combated the principle of evolution raised by Lamarck and by the author of the *Vestiges of Creation*, he did not, unlike his contemporaries Lyell, Wyman, W. B. Rogers, and others, change his views.

And so it is, in youth the older naturalists of the present generation were taught the doctrine of creation by sudden, cataclysmic, mechanical, "creative" acts; and those to whose lot it fell to come in contact with the ultimate facts and principles of the new biology had to unlearn this view, and gradually to work out a larger, more profound, wider-reaching, and more philosophic conception of creation.